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Page 1 of 21. ECN **169386**Proj.
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2. ECN Category (mark one) Supplemental ☐ Direct Revision ☒ Change ECN ☐ Temporary ☐ Standby ☐ Supersedure ☐ Cancel/Void ☐		3. Originator's Name, Organization, MSIN, and Telephone No. J. R. Brehm, Transition Projects and Spent Fuel Safety Engineering, 376-8602, H4-68		4. Date 11/17/94	
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12. Description of Change Further clarification of the dry pipe sprinkler system was requested and added to the document (See page # 6 of the document). The failure probability of 1.0 E-03 was changed to 5.0 E-01 for the eighth and final event, referring to the roll-up doors with the seals (see page #9 of the document).					
13a. Justification (mark one) Criteria Change ☒ Design Improvement ☐ Environmental ☐ As-Found ☐ Facilitate Const. ☐ Const. Error/Omission ☐ Design Error/Omission ☐					
13b. Justification Details In response to comments from DOE's (GW Gault) review of this document, the above changes were made.					
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7. Abstract <p>The purpose of this study is to evaluate the probability of potential fires in the Facility 3712 Building that could lead to criticality. This study has been done to support the criticality update (Schwinkendorf 94). In this analysis, two initiating events will be considered. The first is a random fire that is hot enough and sufficiently long enough to burn away the containers and fuel separators such that the fuel can establish a critical mass. The second is a seismically induced fire with the same results.</p>		
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**FIRE CRITICALITY
PROBABILITY ANALYSIS FOR 300 AREA N REACTOR FUEL
FABRICATION AND STORAGE FACILITY**

WESTINGHOUSE HANFORD COMPANY

November 1994

**For the U.S. Department of Energy
Contract DE-AC06-87RL10930**

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1.0 INTRODUCTION

1.1 BACKGROUND

Uranium fuel assemblies and other uranium associated with the shutdown N Reactor are stored in the 300 Area N Reactor Fuel Fabrication and Storage Facility (Facility). Westinghouse Hanford Company (WHC) requires safety analyses to demonstrate that safety requirements of *Nuclear Criticality Safety*, DOE Order 5480.24 and *Nonreactor Facility Safety Analysis Manual*, WHC-CM-4-46 are met. The 3712 Building, where the majority of the fuel assemblies and other uranium is stored, is where there could be a potential for a criticality bounding case. Safety analysis for criticality in Building 3712 includes estimating the risk of each event in an accident sequence of events that could involve fires and compromise the configuration of fuel. Calculating the risk involves developing the frequencies and consequences of accident sequences. This study only considers the frequencies.

1.2 PURPOSE

The purpose of this study is to evaluate the probability of potential fires in the Facility 3712 Building that could lead to criticality. This study has been done to support the criticality update (Schwinkendorf 94). For criticality to occur, the wooden fuel assembly containers would have to burn such that the fuel inside would slump into a critical geometry configuration, a sufficient number of containers burn to form an infinite wide configuration, and sufficient water (about a 17 inch depth) be placed onto the slump. To obtain the appropriate geometric configuration, enough fuel assembly containers to form an infinite array on the floor would have to be stacked at least three high. Administrative controls require the stacks to be limited to two high for 1.25 wt% enriched finished fuel¹. This is not sufficient to allow for a critical mass regardless of the fire and accompanying water moderation. It should be noted that 0.95 wt% enriched fuel and billets are stacked higher than only two high. In this analysis, two initiating events will be considered. The first is a random fire that is hot enough and sufficiently long enough to burn away the containers and fuel separators such that the fuel can establish a critical mass. The second is a seismically induced fire with the same results.

¹Administrative controls limit the stacking of 0.95 wt% enriched fuel assemblies to three high and limit the stacking of 1.25 wt% enriched fuel to two high. Storage boxes of 1.25 wt% fuel, the most reactive, have been analyzed; 0.95 wt% fuel storage mis-stacked do not represent a criticality concern (Schwinkendorf). Storage boxes of 1.25 wt% fuel assemblies mis-stacked to five high, without interspersed moderation and without a fire, reached a k_{eff} of 0.955 and a k_{eff} 0.963 at 2σ . Introduction of interspersed moderation reduces the k_{eff} to less than 0.95 because of the effect of thermal versus absorption effects of water introduction in small versus large arrays.

1.3 APPROACH

Event trees identify sequences of events that can cause accidents and provide a structured method for integrating the various factors involved to determine accident frequencies. The event tree contains a series of questions, called top events. The top events define accident sequences. The decisions or "branch" points under these top events are described and discussed with each event tree. The frequencies of the sequences are the products of the frequency of the initiator and the probabilities assigned to each top event in the sequence.

The ETA-II microcomputer software was used to generate the event trees. Although ETA-II has the capability to quantify the accident sequences, ETA-II quantification was verified by hand calculations.

2.0 ACCIDENT SEQUENCES

Two event trees were developed to describe the sequence of events starting with a fire and ending in a criticality. An event tree was developed to describe the potential sequence of events if a random fire were to occur in Facility 3712 Building with respect to a potential criticality. The event tree is shown on Figure 2-1. The second event tree describes the sequence of events that could occur if an earthquake caused the fire leading to criticality, and is shown on Figure 2-2. Each event in the event trees is described and quantified in Sections 2.1 and 2.2 of this report.

2.1 RANDOM FIRE

The first event or initiator, FIRE, is a randomly occurring fire. Ignition sources considered were electrical and normal operating experience. Smoking was not considered as an ignition source since it is not allowed in DOE facilities. It is estimated that there have been four fires in the 25 last year history of the Facility, thus $4/25$ equals 0.16 per year. A reference was not found for this frequency, but plant personnel interviewed did not disagree with the value. If anything, they indicated that some of the fires of the past could not happen now because of the change in missions. However, a frequency with a factor 10 to 100 increase to 1.6 or 16 fires per year would not cause a significant change in the outcome.

There is a 500 gallon propane storage tank outside the Facility 3716 Building, thirty feet away. The tank provides a propane supply to the Battelle Pacific Northwest Laboratories (PNL) 306 W Building. The tank has been inspected and appears to be within the standard Department of Transportation requirements for flammable gases. The tank has 4 inch steel legs and stands on a concrete pad. It is located on the side of the 3716 Building where traffic is infrequent; the only identified need for vehicle traffic would be for the purpose of filling the tank. It is anticipated that if the approximate 5/8 in. copper tubing line from the tank were to break, the propane flow would be adequately restricted so that large amounts of gas would not collect for a major fire or explosion. There are no identified ignition sources in the vicinity of the tank; electrical lines in the vicinity are underground. If the propane was ignited, flames would be more like a torch out of the tubing and would not impact the 3712 Building. Propane tank fires were considered in the random fire probability. It is believed that the frequency of random fires used in this analysis, 0.16 per year, encompasses fires associated with the tank.

The second event, STACK, deals with the stacking of wooden containers of fuel in the 3712 Building. There are administrative controls to limit the stacks of 1.25 wt% enriched fuel to two high. A stack two high could not form a critical geometry if collapsed to an optimum spaced geometry, moderation, and infinite reflection. However, a stack of three in an infinite array would conceivably form a critical geometry (calculated $K_{eff} \geq 0.98$) if the wooden containers and fuel spacers are destroyed or removed and optimum spacing, moderation, and reflection is achieved. It should be noted that only 10 percent of the fuel stored is enriched to 1.25 wt% and it would require multiple stacks of three high to form an infinite array. Based on the facts that access to the fuel requires obtaining a key, the buddy system is used,

Figure 2-1. Random Fire Criticality Event Tree.

300 AREA N FUELS FACILITY TED.TRE 11-10-93

Figure 2-2. Seismic Induced Fire Criticality Event Tree.

and a shift lead oversees the work, a human error probability of $1.0 \text{ E-}04$ was used (Dougherty 1988). Additionally, the shift lead's effort is reviewed monthly, and a Criticality Safety Representative inspection is performed monthly. At least one storage location is inspected each month and all locations are inspected during the year.

The third event, SPRINKLER, is failure of the fire suppression sprinkler system in the 3712 Building. The fire suppression system is a dry pipe system with multiple sprinkler heads; when a fusible link in the head melts, this relieves the air pressure in the line down stream from the suppression system valve and allows water to enter into the pipe. The probability of failure of a dry pipe system is $1.0 \text{ E-}07$ per demand (Dexter 1982). Based on test data (Evans and Grill 1992) the dry sprinkler systems priming is tested and system components inspected every four months at Hanford. Of the 936 tests performed, one test failure was found. This would lead to a failure probability of $1.07 \text{ E-}03$. The test and therefore its failure is more stringent than an actual fire. The valve of the sprinkler system is tested to assure that it unseats with a minimal pressure change, but without full flow of the water. In an actual fire, the pressure in the dry pipe is released to the atmosphere so that there is no restriction on the valve opening by the water pressure. Steve Eide (Eide, et al 1990) indicated that he found a failure per demand for a dry pipe sprinkler system of 1 in 100, this includes all elements of the system, (i.e., a lack of water, pipe break, etc.). This failure rate is what was used for this event on the event tree. If the fire protection system fails, the fire is not controlled at this point in time, but there would be no water to develop the optimum moderation.

The fourth event, CONTROL occurs if the Hanford Fire Department fails to control the fire. A combustible loading study (Myott 1993) indicates that a four hour fire could potentially consume all of the wood fuel separators. This would lead to the potential slumping of the fuel into a critical geometry. Based on a telephone conversation with the Hanford Fire Chief's office, any place on the 300 Area site could be reached in 2 to 4 minutes from departure from the 300 area fire station. The 400 area fire station would be dispatched as a backup. They would probably take an additional 5 minutes. The point is that there would be considerable time left to fight the blaze before the wood separators could be consumed. Attempting to develop a probability for this event has been a difficult task. There are insufficient maintained records available with fire department successes and failures at Hanford that could be formed into a probability. The Department of Energy (DOE) requires that a written report be made for every vehicle accident on site that has a certain dollar value. Initially, the dollar value was \$250 and later was revised to \$500. A search was made of these accident reports from the Hanford Transportation Department. Between 1983 and 1990, there were 65 such reportable accidents involving large trucks. Of these 65, 8 involved fire vehicles of some sort. The short summaries of these accidents indicated that all 8 were minor such as losing a mirror, backing into a telephone pole, or not clearing a corner properly. The fire chiefs office indicated that these accidents involved tank trucks spraying for brush fires in abnormal places. As stated earlier when the 200 area fire dispatcher dispatches to a fire in the 300 area, the 300 area station is sent with a backup from the 400 area station. Two types of vehicles would be sent from each station, a telesquirt and a pumper. For the type of fire in this accident, it is assumed that the pumper with hoses would be used. The dispatcher could also dispatch other stations such as the 200 area station or ask for help from the city of Richland. It was conservatively assumed that if a fire truck was involved in

any kind of accident, it would not get to the fire. Statistics maintained at Hanford to fulfill a DOE requirement indicates that there were 65 truck accidents at Hanford in 32,055,000 miles travelled. Eight of these involved fire vehicles. This leads to a failure rate of $2.5 \text{ E-}07$ per mile for fire vehicles. If we assume a conservative 20 miles of travel, for the 300 and 400 area fire vehicles, this leads to a failure probability of $9.98 \text{ E-}06$ that neither pumper from the two stations would make it to the fire. There is also the possibility that the signal would not be sent to the dispatcher due to component failures. The fire detection and alarm system is electronic². Typical failure rates for these types of components are in the range of $1.0 \text{ E-}06$ to $1.0 \text{ E-}05$ per demand, and it would require multiple component failures for the system failure to approach the $1.0 \text{ E-}04$ probability assumed for this event.

The fifth event, MODERATION, exists for the sequences where either the sprinkler system has activated or the Fire Department has responded. It suggests that only enough water was delivered in controlling the fire to cause optimum moderation of the fuel. A water depth of 17.3 inches or more would have to collect to cover the fuel and provide optimum moderation. The water level does not consider the fact that there would be other materials present such as ash from the burnt containers or metal from the bolts through the cases that might have to be displaced to form the optimum moderation. Even though there are many unknowns which make this event extremely unlikely, a probability of $1.0 \text{ E-}01$ was used for this event.

The sixth and final event, DOORS, is failed if the roll-up doors with seals do not prevent the accumulation of sufficient water for moderation. The floor of the 3712 Building has two 16 foot wide roll-up doors on the west side of the building. These doors have 4.5 inch high drainage flaps to let water out. It is anticipated that these devices will prevent water from collecting on the floor and thus causing optimum moderation of the fuel (17.3 inches of water minimum). Also, the sheet metal walls probably could not support the weight of 17 inches of water, but if they could they would leak. A failure probability of $1.0 \text{ E-}03$ was used for this event. This is an engineering judgement and takes into account that nearly 80,000 gallons of water would be put on the fire and not leak out the doors or cracks in the sheet metal walls. There are two fire hydrants that would be available. A recent flow meter test indicates that the combined flow at 20 pounds pressure would be 3,027 gpm. At this rate it would take nearly 30 minutes of flow to realize 80,000 gallons.

²The fire alarm system circuits are supervised. Each of the three detectors that sense alarm conditions are normally-open contact devices connected in a series-parallel configuration. An End of Line device located at the most remote location of each detection circuit allows a small supervisory current to flow through the detection circuits. If somehow the circuit is disconnected or "opened" such that it could not send a signal, the small monitoring current would be disrupted and a trouble alarm signal would be transmitted to the fire station; fire station personnel are then dispatched to troubleshoot the alarm. There is also a supervised temperature sensor (for sensing a freezing condition). The manual alarm box circuit, the audible alarms circuit, and the interface circuits between the alarm panel and the RFAR transmitter panel which sends the signal to the fire station, are also supervised.

The fire event tree shows eight accident sequences. Sequences 1 through 3 result in a safe or acceptable condition. The fourth accident sequence does result in a criticality, but the frequency of this series of events is $9.9 \text{ E-}09$ per year. In this sequence, the sprinkler system functions, and the water collects to an optimum moderation due to the plugged flaps on the roll-up doors. This frequency is less probable than the WHC criteria ($1.0 \text{ E-}06$ per year) used at Hanford for credible accident frequencies. Sequences 5 and 6 also result in acceptable outcomes. Sequence 7 is like sequence 4. In this sequence the sprinkler system fails, but the Fire Department is available and the roll-up door flaps plug allowing water to collect. The frequency for this incredible sequence is $1.6 \text{ E-}11$ per year. This is well below the criteria mentioned above. In the last sequence, the fire is not controlled, but due to the fact that there is no water available for moderation there is no criticality. The frequency of this sequence is also $1.6 \text{ E-}11$ per year. $1.0 \text{ E-}04$ of this frequency is the stacking error on the fuel bundles which does not affect the fire outcome. Therefore, the uncontrolled random fire frequency is really $1.6 \text{ E-}07$ per year.

2.2 SEISMIC INDUCED FIRE

The second event tree was developed to show the sequence of events for a seismically induced fire leading to a criticality of the stored fuel in Building 3712.

The first event, SEISMIC, has a frequency of $1.11 \text{ E-}03$ per year (Tallman, et al 1989). This is based on the 1985 UBC indicating that the sprinkler system might fail with a 0.05 g load.

The second event, FIRE, is an engineering judgement that 1 out of 100 buildings subject to an earthquake has a fire³.

The third event, FUEL, is also an engineering judgement using a fifty percent value. Cardboard boxes and other items of potentially rapid flammability have been stored in certain parts of the 3712 Building in the past but have since been removed. Conceivably some could be introduced. The question is whether or not the fire initiator is in the vicinity of the easily flammable materials.

The fourth event, STACK, represents a potential human error which stacks the fuel cases greater than two high. Based on the facts that access to the fuel requires obtaining a key and the buddy system is used, a human error probability of $1.0 \text{ E-}04$ was used (Dougherty 1988).

The fifth event, SPRINKLER, assumes that the earthquake disables the fire control system which is not a Safety Class System with a probability of 1, but 50% of the time it fails in the dry pipe portion which allows water to flow onto the fire.

³This probability was arrived at by the author and the peer reviewer based on their experience living in northern and southern California and their recollection of the fires associated with earthquakes. Even though most of the homes and buildings are heated with natural gas, the news reporting of the damage only infrequently deals with fires.

The sixth event, EXTER, indicates the sprinkler system fails in the water source external to the building with a probability of 0.5. When this happens, there is no water available to spray on the fire.

The seventh event, CONTROL, refers to the Fire Department response to the alarm. The probability of failing to control a fire has been increased to $1.0 \text{ E-}02$ from the $1.0 \text{ E-}04$ used for control of the random fire discussed above in the previous event tree. This is to account for the fact that there is no prioritizing of calls received under earthquake conditions.

The eighth event, MODERATION, exists for the sequences where either the sprinkler system has activated or the Fire Department has responded. It suggests that only enough water was delivered in controlling the fire to cause optimum moderation of the fuel. A probability of $1.0 \text{ E-}01$ was used for this event on the same basis as discussed for the equivalent event in the first event tree. As noted earlier, the fuel needs to be covered with water requiring the water level to reach 17.3 inches for moderation.

The ninth and final event, DOORS, refers to the roll-up doors with seals. The 3712 Building has two 16 foot wide roll doors on the west side of the building. These doors have 4.5 inch high drainage flaps to let water out. It is anticipated that these devices will prevent water from collecting on the floor and thus causing optimum moderation of the fuel (17.3 inches of water minimum). A failure probability of $5.0 \text{ E-}01$ was used for this event. This is an engineering judgement and takes into account that nearly 80,000 gallons of water would be put on the fire and not leak out the doors or cracks in the sheet metal walls.

The seismic induced fire event tree shows 12 accident sequences. Sequences 1 through 5 result in a safe or acceptable condition. The sixth accident sequence leads to a criticality with a frequency of $3.47 \text{ E-}11$ per year. In this case the sprinkler system has failed in the dry pipe portion allowing water to be sprinkled on the fire and due to the doors failing such that the water can collect on the fuel and optimum moderation is reached. Sequences 7 through 10 also result in a safe or acceptable condition. The eleventh sequence results in a criticality when the Fire Department responds, but the roll-up doors are plugged allowing for optimum moderation to occur. The frequency of this sequence is $6.87 \text{ E-}12$ per year. In the last sequence, the fire is not controlled by either the sprinkler system or the Fire Department, and no criticality occurs due to lack of water for moderation. The frequency of this sequence is $1.39 \text{ E-}12$ per year. A factor of $1.0 \text{ E-}04$ of this frequency is the stacking error on the fuel bundles. This error does not affect the resulting fire and should be removed leaving $6.87 \text{ E-}08$ per year as the frequency. The frequency of the two criticality sequences when summed is $4.16 \text{ E-}11$ per year. This frequency as well as the fire frequency resulting in an unacceptable condition is well below the WHC criteria used at Hanford for accident frequencies.

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3.0 CONCLUSIONS

The frequency of a criticality in Building 3712 due to either a random fire, $1.5 \text{ E-}09$ per year or a seismically induced fire, $4.16 \text{ E-}11$ per year are both much less than the $1.0 \text{ E-}06$ per year frequency criterion of WHC-CM-4-46, Chapter 7, REV. 2 (Risk), Nonreactor Facility Safety Analysis Manual. On this basis, the Facility requires no additional restrictions with respect to risk.

DOE Order 5480.24, *Nuclear Criticality Safety*, indicates that if the "mass of fissionable material exceeds the limits established in paragraph 4.2.1 of ANSI/ANS-8.3, but a criticality accident is determined to be impossible due to the physical form of the fissionable material, or the probability of occurrence is determined to be less than 10^{-6} per year (as documented in a DOE approved SAR), neither a CAS nor a criticality detection system is required." The Facility mass of fissionable material does exceed the limits established in paragraph 4.2.1 of ANSI/ANS-8.3. However, the results of this study indicates that the probability of a criticality occurrence is less than $1.0 \text{ E-}06$ (10^{-6}) per year. Therefore, neither a CAS nor a criticality detection system is required.

Although it was not the purpose of this study to evaluate fires, an uncontrolled random fire was found to have a frequency of $1.6 \text{ E-}07$ per year, and a seismically induced uncontrolled fire has a frequency of $6.87 \text{ E-}08$ per year. The random fire and the seismically induced fire probabilities are below the criterion of WHC-CM-4-46. The consequences for the random fire are discussed in another report (Johnson 1994) and are also below the Risk Acceptance Guidelines of WHC-CM-4-46.

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4.0 REFERENCES

- DOE, 1992 *Nuclear Criticality Safety*, DOE Order 5480.24, U. S. Department of Energy, Washington D. C.
- WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual*, Westinghouse Hanford Company, Richland, Washington.
- Dexter, A. H., W. C. Perkins, 1982, *Component Failure Rate Data With Potential Applicability To Nuclear Fuel Reprocessing Plant*, DP-1633, E.I. du Pont de Nemours, Savannah River Laboratory, Aiken, SC 29808.
- Dougherty, E. M., Jr., 1988, *Human Reliability Analysis*, Advanced Technology Division Science Applications International Corporation, John Wiley & Sons, Inc.
- Eide, et al., 1990, *Generic Component Failure Data Base For Light Water and Liquid Sodium Reactor PRAs*, EGG-SSRE-8875 (Informal Report), Idaho National Engineering Laboratory, Idaho Falls, Idaho.
- Evans, David T., To Grill, Richard P., April 14, 1992, Department of Energy Memorandum. *Additional Information Request - Request for Exemption Inspection and Testing of Fire Protection Equipment*.
- Johnson, D. J., 1994, WHC-SD-NR-RA-003 Rev 0, *Accident Safety Analysis for 300 Area N Reactor Fuel Fabrication and Storage Facility*, Westinghouse Hanford Company, Richland, Washington.
- Myott, C. F., 1993, WHC-SD-NR-TI-053 Rev 0, *Fire Loading Calculations for 300 Area N Reactor Fuel Fabrication and Storage Facility*, Westinghouse Hanford Company, Richland, Washington.
- Schwinkendorf, K. N., 1994, WHC-SD-NR-CSER-010, *Criticality Safety Evaluation Report for the 300 Area N Reactor Fuel Fabrication and Storage Facility*, Westinghouse Hanford Company, Richland, Washington.
- Tallman, A.M., et al., 1989, *Evaluation of Seismic Hazard for Non-Reactor Facilities, Hanford Reservation, Hanford Washington*, WHC-MR-0023, Westinghouse Hanford Company, Richland, Washington.

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